

1. (Previously Presented) An apparatus comprising:  
a substrate;  
a waveguide mounted on the substrate; and  
an optoelectronic chip bonded to the substrate and having an optical element on a bottom surface of the optoelectronic chip directly engaging a top surface of the waveguide.
2. (Original) An apparatus as defined in claim 1, wherein the optoelectronic chip is a flip-chip.
3. (Original) An apparatus as defined in claim 1, wherein the optical element comprises a transceiver, a receiver or a transmitter.
4. (Original) An apparatus as defined in claim 1, wherein the optoelectronic chip is bonded to the substrate via an electrical connection between facing surfaces of the optoelectronic chip and the substrate.
5. (Original) An apparatus as defined in claim 1, further comprising an underfill material disposed between the optoelectronic chip and the substrate.
6. (Original) An apparatus as defined in claim 1, wherein the underfill is not disposed between the optical element and the waveguide.

7. (Original) An apparatus as defined in claim 1, wherein the waveguide includes a mirror.

8. (Original) An apparatus as defined in claim 7, wherein the mirror includes a metallized mirror.

9. (Original) An apparatus as defined in claim 1, wherein the waveguide includes a volume diffraction grating.

10. (Original) An apparatus as defined in claim 1, wherein the waveguide includes a planar waveguide.

11. (Previously Presented) An apparatus comprising:  
a substrate;  
a flip-chip having a bottom surface and an optical element on the bottom surface;  
a waveguide at least partially disposed between the substrate and the flip-chip, the waveguide having a thermal stability sufficient to withstand a flip-chip bonding temperature;  
and  
solder bumps to couple the flip-chip to the substrate such that the optical element directly engages a top surface of the waveguide.

12. (Original) An apparatus as defined in claim 11, wherein facing surfaces of the flip-chip and the substrate are electrically connected.

13. (Original) An apparatus as defined in claim 11, wherein a tension force associated with the solder bumps draws the flip-chip and the substrate together when the solder bumps are soldered.

14. (Original) An apparatus as defined in claim 13, wherein the tension force causes the flip-chip to engage the waveguide.

15. (Original) An apparatus as defined in claim 13, wherein the tension force causes the optical element to directly engage the waveguide.

16. (Original) An apparatus as defined in claim 11, wherein the flip-chip is positioned on the substrate using a thermocompression bonder in a z-axis distance control mode.

17. (Original) An apparatus as defined in claim 16, wherein the thermocompression bonder causes the flip-chip to directly engage the waveguide.

18. (Original) An apparatus as defined in claim 16, wherein the thermocompression bonder causes the optical element to directly engage the waveguide.

19. (Previously Presented) An apparatus comprising;  
a substrate having a first plurality of solder bumps;  
a waveguide mounted to the substrate; and  
a flip-chip having an optical element and a second plurality of solder bumps, the first and second plurality of solder bumps having a combined thickness prior to soldering which is greater than a height of the waveguide to cause the optical element to directly engage a top surface of the waveguide after a soldering process.

20. (Original) An apparatus as defined in claim 19, wherein, after soldering, the combined thickness is approximately equal to the height of the waveguide.

21. (Original) An apparatus as defined in claim 19, wherein the waveguide has a glass transition temperature above the melting point of the solder bumps.

22. (Original) An apparatus as defined in claim 19, wherein the substrate includes a FCPGA substrate.

23. (Previously Presented) An apparatus comprising;  
a substrate;  
a flip-chip coupled to the substrate;  
an optically active waveguide mounted to the substrate and directly engaging the flip-chip; and,  
a passive waveguide not configured to conduct light corresponding to the operation of the flip-chip and located to maintain a predetermined separation between the flip-chip and the substrate.

24. (Original) An apparatus as defined in claim 23, wherein the active waveguide and the passive waveguide are separate waveguides.

25-44. (Cancelled)

45. (Previously Presented) An apparatus as defined in claim 1, further comprising a solder bond between the substrate and the optoelectronic chip to hold the optical element in direct engagement with the waveguide.

46. (Previously Presented) An apparatus as defined in claim 11, wherein the solder bumps are further to hold the optical element in direct engagement with the waveguide.

47. (Previously Presented) An apparatus as defined in claim 11, wherein the solder bumps are further to hold the optical element in direct engagement with the waveguide.

48. (Previously Presented) An apparatus as defined in claim 19, wherein the first and second plurality of solder bumps are further to hold the optical element in direct engagement with the waveguide.

49. (Previously Presented) An apparatus as defined in claim 23, wherein the optically active waveguide is further to directly engage an optical element of the flip-chip.

50. (Previously Presented) An apparatus as defined in claim 49, further comprising a solder bond between the substrate and the flip-chip to hold the optically active waveguide in direct engagement with the optical element of the flip-chip.

51. (New) An apparatus as defined in claim 23, wherein the active waveguide and the passive waveguide are integrally formed.